What is claimed is:

1. A blind digital watermark embedding apparatus based on wavelet transform comprising:

a high-frequency component removing unit for removing high-frequency components from a target image corresponding to a target domain of a wavelet-transformed original image in which watermarks are to be embedded, thereby generating a mirror image corresponding to the target domain free of high-frequency components;

an index information generating unit for generating index information representing pixel positions in the target domain where data of the watermarks are to be embedded, respectively;

a watermark generating unit for generating a data stream of the watermarks to be embedded in the target image; and

a watermark embedding unit for embedding the watermarks of the watermark data stream generated from the watermark generating unit in pixel data of the target image at the pixel positions determined based on the index information from the index information generating unit, respectively.

2. The blind digital watermark embedding apparatus based on wavelet transform according to claim 1, wherein the high-frequency component removing unit generates the mirror image by performing again a 1-level wavelet transform for the target domain of the wavelet-transformed original image, removing high-frequency components from detail domains of the wavelet-transformed target domain, except for an estimate component domain of the wavelet-transformed target domain, and performing an inverse wavelet transform for the resultant target domain.

3. The blind digital watermark embedding apparatus based on wavelet transform according to claim 2, wherein the high-frequency component removing unit removes high-frequency components from the target image by replacing, with a value of "0", values of the high-frequency components in the detail domains of the wavelet-transformed target domain.

4. The digital watermark embedding apparatus based on wavelet transform according to claim 1, wherein the index information

generating unit generates, as the index information, a binary sequence data stream randomly set in accordance with an index information setting key value selected by a user while having the same size as the target domain.

5. The blind digital watermark embedding apparatus based on wavelet transform according to claim 1, wherein the target domain corresponds to a DC component domain obtained from the original image subjected to a wavelet transform at a level determined by a length and embedding strength of the watermark data stream to be embedded, and the level of a degradation in picture quality caused by the embedding of the watermark data stream.

6. The blind digital watermark embedding apparatus based on wavelet transform according to claim 1, wherein the watermark data stream is random data of "1" and "-1" randomly set in accordance with a watermark data stream setting key selected by a user.

7. The blind digital watermark embedding apparatus based on

wavelet transform according to claim 1, wherein when the data value of an watermark in the watermark data stream to be embedded corresponds to a value of "1", the pixel data value of the target image at a position where the watermark is to be embedded is set to be higher than the pixel data value of the mirror image at the same position.

8. The blind digital watermark embedding apparatus based on wavelet transform according to claim 7, wherein when the watermark data value corresponds to "1", the watermark is embedded in the target image by replacing the pixel data value of the target image with the pixel data value obtained by adding a predetermined interval factor to the pixel data value of the mirror image at the same position, as expressed by the following equation, so that a desired interval is maintained between the pixel data value of the target image and the pixel data value of the mirror image.

$$LL_E(idx(i) = LL'(idx(i) + INTERVAL$$

where,

idx(i): the index information representing the position

of the target domain where the watermark is to be embedded;

LL': the pixel data stream of the mirror image corresponding to the target image, but free of high-frequency components; and

$LL_E$: the pixel data stream of a wavelet-transformed DC component domain in which the watermark has been embedded.

9. The blind digital watermark embedding apparatus based on wavelet transform according to claim 1, wherein when the data value of an watermark in the watermark data stream to be embedded corresponds to a value of "-1", the pixel data value of the target image at a position where the watermark is to be embedded is set to be lower than the pixel data value of the mirror image at the same position.

10. The blind digital watermark embedding apparatus based on wavelet transform according to claim 9, wherein when the watermark data value corresponds to "-1", the watermark is embedded in the target image by replacing the pixel data value of the target image with the pixel data value obtained by deducting a predetermined interval factor to the pixel data

value of the mirror image at the same position, as expressed by the following equation, so that a desired interval is maintained between the pixel data value of the target image and the pixel data value of the mirror image.

$$LL_E(idx(i) = LL'(idx(i) - INTERVAL$$

where,

idx(i): the index information representing the position of the target domain where the watermark is to be embedded;

'LL': the pixel data stream of the mirror image corresponding to the target image, but free of high-frequency components; and

$LL_E$: the pixel data stream of a wavelet-transformed DC component domain in which the watermark has been embedded.

11. The blind digital watermark embedding apparatus based on wavelet transform according to claim 8, wherein the predetermined interval factor value is set to a maximum interval between the pixel data values of the target and mirror images capable of preventing a degradation in picture quality.

12. A blind digital watermark extracting apparatus based on wavelet transform comprising:

a high-frequency component removing unit for removing high-frequency components from a target image corresponding to a target domain of a wavelet-transformed original image in which watermarks are to be embedded, thereby generating a mirror image corresponding to the target domain free of high-frequency components;

an index information generating unit for generating index information representing pixel positions in the target domain where data of the watermarks are to be embedded, respectively;

a watermark generating unit for generating a data stream of the watermarks to be embedded in the target image;

a watermark extracting unit for receiving the index information from the index information generating unit, receiving a watermark-embedded image corresponding to a watermark-embedded domain of the wavelet-transformed original image, and extracting a data stream of watermarks from in the watermark-embedded image, based on the index information; and

a watermark comparing unit for checking a similarity between the original watermark data stream from the watermark generating unit and the extracted watermark data stream from the watermark extracting unit, thereby determining whether or not the original watermarks are embedded in the wavelet-transformed original image.

13. The blind digital watermark extracting apparatus based on wavelet transform according to claim 12, wherein the high-frequency component removing unit generates the mirror image by performing again a 1-level wavelet transform for the target domain of the wavelet-transformed original image, removing high-frequency components from detail domains of the wavelet-transformed target domain, except for an estimate component domain of the wavelet-transformed target domain, and performing an inverse wavelet transform for the resultant target domain.

14. The blind digital watermark extracting apparatus based on wavelet transform according to claim 12, wherein the high-frequency component removing unit removes high-frequency

components from the target image by replacing, with a value of "0", values of the high-frequency components in the detail domains of the wavelet-transformed target domain.

15. The digital watermark extracting apparatus based on wavelet transform according to claim 12, wherein the index information generating unit generates, as the index information, a binary sequence data stream randomly set in accordance with an index information setting key value selected by a user while having the same size as the target domain.

16. The blind digital watermark extracting apparatus based on wavelet transform according to claim 12, wherein the target domain corresponds to a DC component domain obtained from the original image subjected to a wavelet transform at a level determined by a length and embedding strength of the watermark data stream, and the level of a degradation in picture quality caused by the embedding of the watermark data stream.

17. The blind digital watermark extracting apparatus based on

wavelet transform according to claim 16, wherein the watermark data stream is random data of "1" and "-1" randomly set in accordance with a watermark data stream setting key selected by a user.

18. The blind digital watermark extracting apparatus based on wavelet transform according to claim 12, wherein the watermark extracting unit compares the pixel data value of the target image at a position where a watermark of the watermark data stream embedded in the target image is embedded, with the pixel data value of the mirror image at the same position, and outputs a watermark data value selected from two opposite values based on whether or not the pixel data value of the target image is higher than the pixel data value of the mirror image at the same position.

19. The blind digital watermark extracting apparatus based on wavelet transform according to claim 18, wherein the watermark extracting unit determines the watermark data value to be "1" when the pixel data value of the target image is higher than the pixel data value of the mirror image at the same position,

while determining the watermark data value to be "-1" when the pixel data value of the target image is not higher than the pixel data value of the mirror image at the same position.

20. The blind digital watermark extracting apparatus based on wavelet transform according to claim 18, wherein the watermark comparing unit checks the similarity between the watermark data stream from the watermark generating unit and the extracted watermark data stream from the watermark extracting unit by calculating a correlation value between the watermark data streams.

21. The blind digital watermark extracting apparatus based on wavelet transform according to claim 20, wherein the watermark comparing unit calculates the correlation value between the watermark data streams using the following equation, and determines that the original watermarks are embedded in the wavelet-transformed original image when the calculated correlation value is high, while determining that the original watermarks are not embedded in the wavelet-transformed original image when the calculated correlation value is low:

$$Sim(w, w_E') = \frac{\sum_{i=1}^{WM\ Length} w(i) \cdot w_E'(i)}{\sum_{i=1}^{WM\ Length} w_E'(i) \cdot w_E'(i)}$$

where,

WM_Length: a watermark data stream length;

w(i): the watermark data stream from the watermark generating unit; and

$w_E'(i)$: the extracted watermark data stream from the watermark extracting unit.

22. A digital watermark embedding method in a wavelet-based blind digital watermark embedding apparatus including a high frequency removing unit, an index information generating unit, a watermark generating unit, and a watermark embedding unit, comprising the steps of:

(a) executing a multi-level wavelet transform at a level corresponding to the size of a data stream of watermarks to be embedded, for an original image in which the watermarks are to be embedded, and setting a target domain of the wavelet-transformed image in which the watermarks are to be embedded;

(b) removing high-frequency components from a target image corresponding to the set target domain, thereby generating a mirror image corresponding to the target image, but free of high-frequency components;

(c) generating index information representing pixel positions in the target domain where data of the watermarks are to be embedded, respectively; and

(d) embedding the watermark data stream in pixel data of the target image at the pixel positions determined based on the index information, respectively.

23. The digital watermark embedding method according to claim 22, wherein the target domain is set, at the step (a), by a DC component domain obtained from the original image subjected to a wavelet transform at a level determined by a length and embedding strength of the watermark data stream to be embedded, and the level of a degradation in picture quality caused by the embedding of the watermark data stream.

24. The digital watermark embedding method according to claim 22, wherein the index information is a binary sequence data

stream randomly set in accordance with an index information setting key value selected by a user while having the same size as the target domain.

25. The digital watermark embedding method according to claim 22, wherein the step (d) comprises the steps of:

(d1) checking the data value of a watermark of the watermark data stream to be embedded in the target domain at a position where the watermark is to be embedded;

(d2) if the watermark data value corresponds to "1", then setting the data value of a pixel in the target image at the position to be higher than the data value of a pixel in the mirror image at the same position; and

(d3) if the watermark data value corresponds to "-1", then setting the pixel data value of the target image to be lower than the pixel data value of the mirror image.

26. The digital watermark embedding method according to claim 25, wherein the step (d2) comprises the step of:

replacing the pixel data value of the target image with the pixel data value obtained by adding a predetermined

interval factor to the pixel data value of the mirror image at the same position, as expressed by the following equation, so as to maintain a desired interval between the pixel data value of the target image and the pixel data value of the mirror image, thereby embedding the watermark in the target image:

$$LL_E(idx(i) = LL'(idx(i) + INTERVAL$$

where,

idx(i): the index information representing the position of the target domain where the watermark is to be embedded;

LL': the pixel data stream of the mirror image corresponding to the target image, but free of high-frequency components; and

$LL_E$: the pixel data stream of a wavelet-transformed DC component domain in which the watermark has been embedded.

27. The digital watermark embedding method according to claim 25, wherein the step (d3) comprises the step of:

replacing the pixel data value of the target image with the pixel data value obtained by deducting a predetermined interval factor to the pixel data value of the mirror image at

the same position, as expressed by the following equation, so as to maintain a desired interval between the pixel data value of the target image and the pixel data value of the mirror image, thereby embedding the watermark in the target image:

$$LL_E(idx(i) = LL'(idx(i) - INTERVAL$$

where,

idx(i): the index information representing the position of the target domain where the watermark is to be embedded;

LL': the pixel data stream of the mirror image corresponding to the target image, but free of high-frequency components; and

$LL_E$: the pixel data stream of a wavelet-transformed DC component domain in which the watermark has been embedded.

28. The digital watermark embedding method according to claim 25, wherein the predetermined interval factor value is set to a maximum interval between the pixel data values of the target and mirror images capable of preventing a degradation in picture quality.

29. The digital watermark embedding method according to claim 22, wherein the watermark data stream is random data of "1" and "-1" randomly set in accordance with a watermark data stream setting key selected by a user.

30. The digital watermark embedding method according to claim 22, wherein the target domain corresponds to a DC component domain obtained from the original image subjected to a wavelet transform at a level determined by a length and embedding strength of the watermark data stream to be embedded, and the level of a degradation in picture quality caused by the embedding of the watermark data stream.

31. A digital watermark extracting method in a wavelet-based blind digital watermark extracting apparatus including a high frequency removing unit, an index information generating unit, a watermark generating unit, a watermark extracting unit, and a watermark comparing unit, comprising the steps of:

(a') generating position information about pixels in which a data stream of original watermarks has bee embedded, based on a target image corresponding to a target domain of a

wavelet-transformed original image in which the original watermark data stream has been embedded;

(b') receiving data of pixels in the target domain in which the original watermark data stream has been embedded;

(c') extracting a watermark data stream from the received pixel data at positions determined based on the pixel position information; and

(d') checking a similarity between the original watermark data stream and the extracted watermark data stream, thereby determining whether or not the original watermarks are embedded in the wavelet-transformed original image.

32. The digital watermark extracting method according to claim 31, wherein the target domain is set, at the step (a'), by a DC component domain obtained from the original image subjected to a wavelet transform at a level determined by a length and embedding strength of the original watermark data stream, and the level of a degradation in picture quality caused by the embedding of the original watermark data stream.

33. The digital watermark extracting method according to claim

31, wherein the step (c') comprises the steps of:

(c'1) comparing the pixel data value of the target image at a position where a watermark of the watermark data stream embedded in the target image is embedded, with the pixel data value of the mirror image at the same position; and

(c'2) outputting a watermark data value selected from two opposite values based on whether or not the pixel data value of the target image is higher than the pixel data value of the mirror image at the same position.

34. The digital watermark extracting method according to claim 33, wherein the step (c') comprises the steps of:

if the pixel data value of the target image is higher than the pixel data value of the mirror image at the same position, then outputting a value of "1" as the watermark data value; and

if the pixel data value of the target image is not higher than the pixel data value of the mirror image at the same position, then outputting a value of "-1" as the watermark data value.

35. The blind digital watermark extracting method according to claim 31, wherein the step (d') of determining whether or not the original watermarks are embedded in the wavelet-transformed original image comprises the steps of:

calculating a correlation value between the watermark data streams using the following equation; and

determining that the original watermarks are embedded in the wavelet-transformed original image when the calculated correlation value is high, while determining that the original watermarks are not embedded in the wavelet-transformed original image when the calculated correlation value is low:

$$Sim(w, w_E') = \frac{\sum_{i=1}^{WM\ Length} w(i) \cdot w_E'(i)}{\sum_{i=1}^{WM\ Length} w_E'(i) \cdot w_E'(i)}$$

where,

WM_Length: a watermark data stream length;

w(i): the original watermark data stream; and

$w_E'(i)$: the extracted watermark data stream.

36. The digital watermark extracting method according to claim

31, wherein the original watermark data stream is random data of "1" and "-1" randomly set in accordance with a watermark data stream setting key selected by a user.

37. The digital watermark extracting method according to claim 31, wherein the target domain corresponds to a DC component domain obtained from the original image subjected to a wavelet transform at a level determined by a length and embedding strength of the original watermark data stream, and the level of a degradation in picture quality caused by the embedding of the original watermark data stream.